REMARKS

Claims 1-34 are pending in the present application. No amendment has been made in this response.

Claims 1-3, 6-7, 10-17, 20-23, 26-29, and 32-34 stand rejected under 35 USC 103(a) as being unpatentable over Huang et al. (US 6,067,292) in view of Kadous et al. (US 6,654,408)

Claims 1-3, 6-7, 10-17, 20-23, 26-29, and 32-34 stand rejected under 35 USC 103(a) as being unpatentable over Huang et al. in view of Kadous et al. The examiner alleges that the combination of Huang et al. and Kadous et al. discloses all claimed features and therefore makes the claims unpatentable for being obvious. This allegation is not supported by the cited references; applicants respectfully traverse the rejections for the following reasons.

1. The present invention

The present invention is based on the realization that weak signal components in a transformed signal are amplified with high gain, resulting in high levels of noises in themselves and consequently in the

transformed signal. Applicants discovered that the reduction of noises from the weak signal components effectively reduces the noises in the transformed signal. See, *e.g.*, [[0034], [0025]. The present invention achieves the reduction of noises in a transformed signal by first reconstructing one or more weakest signal components to reduce their noises, and then replacing the reconstructed signal components for their corresponding un-reconstructed ones. See, *e.g.*, [0044]-[0049]. In the reconstructing/replacing process, <u>no signal component is cancelled</u> and therefore the orthogonality of signal components of the transformed signal is not destroyed. See, *e.g.*, [0026]. Furthermore, the identification of signal components for reconstruction is based on channel parameters (*e.g.*, smallest channel coefficients). See, *e.g.*, [0040], [0044]. As discussed hereinbelow, the present invention differs from the cited references in both principle and implementation.

2. Claimed subject matters in Claims 1-3, 6-7, 10-17, 20-23, 26-29, and 32-34

The claimed subject matters as represented by claim 1 are directed to methods and systems for reducing noise in a transformed signal

having a plurality of signal components which are orthogonal to each other. The noise of the transformed signal is reduced by identifying one or more signal components having one or more smallest channel coefficients based upon a channel estimate of said plurality of signal components, reconstructing a predetermined number of times of the identified one or more signal components to thereby reduce noise, and replacing said identified one or more signal components for reconstruction with the reconstructed one or more signal components to provide a new transformed signal having one or more reconstructed signal components with reduced noise. As highlighted above, the reduced noise transformed signal is achieved by a sequence of operations that are not taught or suggested by the cited references, even if the cited references are impermissibly combined.

3. No *prima facie* case of obviousness for Claims 1-3, 6-7, 10-17, 20-23, 26-29, and 32-34 over Huang et al. and Kadous et al.

First, Huang et al. disclose a CDMA receiver that removes the pilot signal from the received signal. See, *e.g.*, Abstract. The removal of the pilot signal is achieved by two steps: reconstructing all

pilot signals from all paths and cancelling (*i.e.*, subtracting) other paths' pilot signals with the reconstructed pilot signals, thereby reducing the path interferences in the transformed signal. See, *e.g.*, Figure 6; Figure 8; Figure 22; Figure 23; col 7, lines 65-67; col 8, lines 1-22. It is evident that the reduction of path interferences by removing pilot signals from all signal components is completely different from the claimed subject matter of the present invention. As discused above, the claimed subject matters of claims 1-3, 6-7, 10-17, 20-23, 26 -29 and 32-34 are directed to methods and systems that reconstruct one or more weakest subcarriers in a transmitted signal and then replace the correspondingly original weakest subcarriers with the reconstructed subcarriers so that the noises resulting from the high amplification gain of the weakest subcarriers are reduced or eliminated, achieving the reduction of noise in the transformed signals. It is apparent that Huang et al. fail to teach or suggest the reduction of noises in a transformed signal by reconstrcuting one or more weakest subcarriers. For the sake of argument heretofore, even with the teaching of Kadous et al. that enables the identifcation of the weakest paths in a transmitted signal, the impermissible combination of Huang et al. and Kadous et al. fails to reach the claimed subject

matters of the present invention. Therefore, applicant respectfully submits that no *prima facie* case of obviousness for claims 1-3, 6-7, 10-17, 20-23, 26 -29 and 32-34 be made over Huang et al. and Kadous et al.

Second, the differences between Huang et al. and the present invention are illustrated in the following mutual applications.

i) Application of the algorithm from Huang et al into the system of the present invention

<table>
<tr><th></th><th>Huang et al</th><th>The present invention</th></tr>
<tr><td>Received Signal</td><td colspan="2">Assuming the same received signals
$$\mathbf{r} = \underbrace{\begin{bmatrix} r_1 \\ r_2 \\ \vdots \\ r_M \end{bmatrix}}_{\text{Received signal}} = \underbrace{\begin{bmatrix} \gamma_1 & & & \\ & \gamma_2 & & \\ & & \ddots & \\ & & & \gamma_M \end{bmatrix}}_{\text{Channel Matrix}} \underbrace{\begin{bmatrix} s_1 \\ s_2 \\ \vdots \\ s_M \end{bmatrix}}_{\text{Transmitted signal}} + \underbrace{\begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_M \end{bmatrix}}_{\text{Noise}}$$</td></tr>
<tr><td>Reconstruction</td><td colspan="2">Assuming one component of signal on r_1 i.e., $\hat{r}_1 = \gamma_1 \cdot s_1$ is reconstructed perfectly</td></tr>
<tr><td>Output to Demodulator</td><td>Cancellation (cancel $\hat{r}_1$ from r_1)
$$\begin{bmatrix} r_1 - \hat{r}_1 \\ r_2 \\ \vdots \\ r_M \end{bmatrix} = \begin{bmatrix} \gamma_1 & & & \\ & \gamma_2 & & \\ & & \ddots & \\ & & & \gamma_M \end{bmatrix} \begin{bmatrix} 0 \\ s_2 \\ \vdots \\ s_M \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_M \end{bmatrix}$$</td><td>Replacement (replace r_1 with $\hat{r}_1$)
$$\begin{bmatrix} \hat{r}_1 \\ r_2 \\ \vdots \\ r_M \end{bmatrix} = \begin{bmatrix} \gamma_1 & & & \\ & \gamma_2 & & \\ & & \ddots & \\ & & & \gamma_M \end{bmatrix} \begin{bmatrix} s_1 \\ s_2 \\ \vdots \\ s_M \end{bmatrix} + \begin{bmatrix} 0 \\ n_2 \\ \vdots \\ n_M \end{bmatrix}$$</td></tr>
<tr><td colspan="3">Note: The outputs after applying the 2 methods to the received signal are different.

• Huang et al teach to remove the effect of the reconstructed component from the composite signal (remove $\hat{r}_1$ from r) in order to further decode other components (without interference from the decoded component). There is no direct effect to noise.</td></tr>
</table>

- The present invention uses the reconstructed component to substitute the received component in the composite signal so that the noise with respect to that component is minimized. There is not intention to remove any signal component or possible interference between components.

ii) Application of the algorithm of the present invention into the system of Huang et al

<table>
<tr><th></th><th>Huang et al</th><th>The present invention</th></tr>
<tr><td>Received Signal</td><td colspan="2">Assuming the same received CDMA signals after experiencing a 2-path fading channel, ignoring the noise:
$$r(t) = \underbrace{\alpha_0 e^{j\phi_0} p(t-\tau_0)}_{\substack{\text{Pilot prtion} \\ \text{Path 0}}} + \underbrace{\alpha_0 e^{j\phi_0} d(t-\tau_0)}_{\substack{\text{Data portion} \\ \text{Path 0}}} + \underbrace{\alpha_1 e^{j\phi_1} p(t-\tau_1)}_{\substack{\text{Pilot portion} \\ \text{Path 1}}} + \underbrace{\alpha_1 e^{j\phi_1} d(t-\tau_1)}_{\substack{\text{Data portion} \\ \text{Path 1}}}$$</td></tr>
<tr><td>Reconstruction</td><td colspan="2">Assuming pilot portion is reconstructed perfectly from Path 0 and Path 1.</td></tr>
<tr><td>Output to Demodulator</td><td>Cancellation
Path 0 $\Rightarrow$
$r(t) - \alpha_1 e^{j\phi_1} p(t-\tau_1)$
$= \alpha_0 e^{j\phi_0} p(t-\tau_0) + \alpha_0 e^{j\phi_0} d(t-\tau_0$
$+\alpha_1 e^{j\phi_1} d(t-\tau_1)$

Path 1 $\Rightarrow$
$r(t) - \alpha_0 e^{j\phi_0} p(t-\tau_0)$
$= \alpha_1 e^{j\phi_1} p(t-\tau_1) + \alpha_1 e^{j\phi_1} d(t-\tau_1)$
$+\alpha_0 e^{j\phi_0} d(t-\tau_0)$</td><td>Replacement
The present invention has difficulty in applying the algorithm directly here to have meaningful replacement.

In the algorithm of the present invention, the reconstructed pilot portion is used to replace the received pilot portion. However, the received pilot portion is not separable from r(t) here before demodulator.
An artificial replacement (perfect) leads to</td></tr>
</table>

		Path 0 $\Rightarrow$ $r(t)$ Path 1 $\Rightarrow$ $r(t)$

It is evident that the two algorithms from Huang et al. and the present invention are not mutually applicable.

Third, while applicant respectfully believe that the above argument be enough for rebutting the rejections, a more detailed discussion of the implementation of the systems and methods disclosed in Huang et al. and the present invention is provided for better illustrating the differences between the references and the claimed subject matters of the present application.

(1) *The features of the received signals in Huang et al.*

The transmitted signal in the system of Huang et al is a summation of pilot and data (102 in FIG 1) as shown in equation (1) below.

$$sg(t) = p(t) + d(t) \qquad (1)$$

The signal arriving at the receiver after passing through the channel is a composite signal which includes L multipath components (illustrated in FIG 6, 601 and 602 for 2 paths). The multipath components are differed in attenuation α, phase ϕ and path delay τ (col 7

line 58-59). Thus the received signal r(t) as (ignoring Gaussian noise for simplicity) may be written in the following equation (2).

$$\begin{aligned} r(t) &= signal\_from\_path\_0 + \ldots + signal\_from\_path\_L-1 \\ &= \alpha_0 e^{j\phi_0} sg(t-\tau_0) + \ldots + \alpha_{L-1} e^{j\phi_{L-1}} sg(t-\tau_{L-1}) \end{aligned} \quad (2)$$

Substituting (2) with (1) gives equation (3) below:

$$\begin{aligned} r(t) &= \alpha_0 e^{j\phi_0} p(t-\tau_0) + \alpha_0 e^{j\phi_0} d(t-\tau_0) && \leftarrow path\_0 \\ &+\ldots && \ldots \\ &+\alpha_{L-1} e^{j\phi_{L-1}} p(t-\tau_{L-1}) + \alpha_{L-1} e^{j\phi_{L-1}} d(t-\tau_{L-1}) && \leftarrow path\_L-1 \end{aligned} \quad (3)$$

Take two-path case for example, as in FIG 6, the received signal (3) with L=2 is represented in equation (4) below:

$$\begin{aligned} r(t) = \alpha_0 e^{j\phi_0} p(t-\tau_0) + \alpha_0 e^{j\phi_0} d(t-\tau_0) + && \leftarrow path\_0 \\ \alpha_1 e^{j\phi_1} p(t-\tau_1) + \alpha_1 e^{j\phi_1} d(t-\tau_1) && \leftarrow path\_1 \end{aligned} \quad (4)$$

With reference to FIG 6, the received signal shown in (4) is before both blocks 611 and 612.

(2) <u>*Reconstructing and cancelling pilot signals in Huang et al.*</u>

Huang et al. teach to first reconstruct pilot signal at each finger (*e.g.*, col 8, line 2-6 or line 31-33). Take Finger 0 in FIG 6 for example, 606 reconstructs pilot signal 0, or $\alpha_0 e^{j\phi_0} pi(t-\tau_0)$ in (4). Then the reconstructed pilot signal is cancelled for each of the other paths (*e.g.*, col 8, line 9-11 or line 34-36). Again in FIG 6, 606 and 607 have reconstructed $\alpha_0 e^{j\phi_0} pi(t-\tau_0)$ and $\alpha_1 e^{j\phi_1} pi(t-\tau_1)$ respectively. For the

upper branch, after the cancellation of the reconstructed pilot from path 1, *i.e.* $\alpha_1 e^{j\phi_1} p(t-\tau_1)$, the signal is represented (suppose reconstruction is perfect without error) in equation (5) below:

$$\begin{aligned} & r(t)-\alpha_1 e^{j\phi_1} p(t-\tau_1) \\ & =\alpha_0 e^{j\phi_0} p(t-\tau_0)+\alpha_0 e^{j\phi_0} d(t-\tau_0) \\ & +\alpha_1 e^{j\phi_1} d(t-\tau_1) \end{aligned} \tag{5}$$

Similarly, the signal at the lower branch after the cancellation of $\alpha_0 e^{j\phi_0} pi(t-\tau_0)$ is represented in equation (6) below:

$$\begin{aligned} & r(t)-\alpha_0 e^{j\phi_0} p(t-\tau_0) \\ & =\alpha_0 e^{j\phi_0} d(t-\tau_0) \\ & +\alpha_1 e^{j\phi_1} p(t-\tau_1)+\alpha_1 e^{j\phi_1} d(t-\tau_1) \end{aligned} \tag{6}$$

And then demodulation is performed to use signals after cancellation (i.e. (5) and (6)).

(3) <u>*The features of received signals of the present invention*</u>

In the present application, the signal components refer to the signals on multiple subcarriers instead of multipath components. The received signal **r** after passing through FFT module 412 is a vector in the format of (equation (2) at [0033] in the present application)

$$\mathbf{r}=\begin{bmatrix} r_1 \\ r_2 \\ \vdots \\ r_M \end{bmatrix}=\begin{bmatrix} \gamma_1 & & & \\ & \gamma_2 & & \\ & & \ddots & \\ & & & \gamma_M \end{bmatrix}\cdot W\cdot\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_M \end{bmatrix}+\begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_M \end{bmatrix} \tag{7}$$

After demodulation of $\underline{\mathbf{x}}$ in (7), the reconstruction and replacing process starts.

(4) *<u>Reconstructing and replacing one or more weakest subcarriers of the present invention</u>*

The present invention first reconstructs one or more weakest subcarriers (*e.g.*, r_1 *being constructed to* $\hat{r}_1$), and then replaces the component r_1 in the received signal $\underline{\mathbf{r}}$ with $\hat{r}_1$. The resulting signal is represented in equation (8) below, assuming perfect reconstruction,:

$$\begin{bmatrix} \hat{r}_1 \\ r_2 \\ \vdots \\ r_M \end{bmatrix} = \begin{bmatrix} \gamma_1 & & & \\ & \gamma_2 & & \\ & & \ddots & \\ & & & \gamma_M \end{bmatrix} \cdot W \cdot \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_M \end{bmatrix} + \begin{bmatrix} 0 \\ n_2 \\ \vdots \\ n_M \end{bmatrix} \qquad (8)$$

It is to be noted that the reconstructed component $\hat{r}_1$ is replacing the r_1 component but not being cancelled/subtracted from the received signal $\underline{\mathbf{r}}$. If the cancellation techniques from Huang et al. are applied, the resultant signal would be represented in equation (9) below under perfect reconstruction assumption:

$$\begin{bmatrix} r_1 - \hat{r}_1 \\ r_2 \\ \vdots \\ r_M \end{bmatrix} = \begin{bmatrix} 0 & & & \\ & \gamma_2 & & \\ & & \ddots & \\ & & & \gamma_M \end{bmatrix} \cdot W \cdot \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_M \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_M \end{bmatrix} \qquad (9)$$

It is evident that equation (8) is not the same as equation (9), demonstrating that the teaching of cancellation disclosed in Huang et al. is not applicable in the present invention.

The signal from the replacement is subject to demodulation again, and these steps may repeat a few times iteratively if desired. See, *e.g.*, [0041]-[0045].

(5) *<u>The reconstructed signal in Huang et al. is NOT applicable in the replacing process of the present invention</u>*

In the CDMA system as described by *Huang et al*, if we want to apply our replacing step, the signal after replacing path-0 pilot p(t) for with the reconstructed $\hat{p}(t)$, would be

$$\hat{r}(t) = \boxed{\alpha_0 e^{j\phi_0} \hat{p}i(t-\tau_0)} + \alpha_0 e^{j\phi_0} da(t-\tau_0) +$$
$$\alpha_1 e^{j\phi_1} pi(t-\tau_1) + \alpha_1 e^{j\phi_1} da(t-\tau_1)$$

which is different from (6). The effect of this replacement is that the noisy received pilot is replaced by a cleaner reconstructed pilot. It is different from that in Huang et al where it is meant to remove the interference caused by the pilot. In fact, it is not possible to do the "replacing" process in practice in the example as the components in r(t) is not separated in the composite signal.

(6) <u>*Kadous et al. fail to supplement the defects in Huang et al. in order to disclose all claimed features of the present invention*</u>

Kadous et al. disclose a method to exploit fast fading to achieve a higher level of diversity and compensate for Doppler and frequency offsets as well as phase noise. In figures 1 and 7, col6, lines 1-6, col 8, lines 20-42, as cited by the examiners, Kadous et al select only a few ***adjacent*** subcarriers to do joint processing instead of using all subcarriers (abstract, col2 line 55, col3 lines 4, 22, 47, 49, 54, 59, col7 lines 31, col9 lines 12, 15, 18, col14, lines 2, 4, col15, lines 31, 49, col16, line 66, col17, lines 8, 45,59, Claims 1, 7, 10, 11, 16, 22-26, or col20, lines 7, 37, 49, 52, col21, lines 36, 64, col22, lines 4, 9, 17, 21, Figures 10). This is because most of the signal information will be concentrated in a few adjacent subcarriers above and below the frequency of the subcarrier frequency in case of imperfection, instead of only one subcarrier in the case without imperfection (col3 lines 58-61, col7 lines 29-31, col9 lines 9-20). If one were to use the method as taught by *Kadous* et al to modify the method of Huang et al, one may identify either the adjacent paths or the stronger paths containing more signal energy for reconstruction and cancellation. Correspondingly, one

may reconstruct the adjacent or the stronger subcarriers in our context. Therefore, the method in *Kadous* et al would by no means teach one to identify one or more signal components having one or more smallest channel coefficients.

(7) *Even if Huang et al. and Kadous et al. are impermissibly combined, they fail to teach or suggest the claimed subject matter*

As discussed above, the teachings from Huang et al. and Kadous et al. are completely different from the claimed subject matter of the present application in terms of concept, principle and implementation. Even if Kadous et al. and Huang et al. are impermissibly combined, they still fail to teach or suggest the claimed subject matters in the present application.

Therefore, the examiner fails to establish a *prima facie* case of obviousness for Claims 1-3, 6-7, 10-17, 20-23, 26-29, and 32-34 over Huang et al. and Kadous et al.

Claims 4, 5, 8, 9, 18, 19, 24, 25, 30, and 31 stand rejected under 35 USC 103(a) as being unpatentable over Huang et al. in view of Kadous et al. and further in view of Dabak et al. (US 2003/0002568)

Claims 4, 5, 8, 9, 18, 19, 24, 25, 30, and 31 stand rejected under 35 USC 103(a) as being unpatentable over Huang et al. in view of Kadous et al. and further in view of Dabak et al. (US 2003/0002568). Applicants respectfully traverse the rejections for the reasons discussed above because Dabak fails to remedy any of defects in Huang et al. and Kadous et al.

Examiner's citation of Huang et al. in the OA corresponding the claimed subject matters in Claim 1 of the present invention

Applicants believe that the above discussion has adequately traversed the examiner's rejections, the three exemplary instances are provided hereinbelow for the sole purpose of showing that the examiner has misread or misinterpretated the prior art in the provision of the reasons for rejections.

1) Col 2, lines 11-25

The claimed subject matter is "a plurality of signal components on different subcarriers which are orthogonal to each other".

The relevant part in col 2, lines 11-25 is "a coherent CDMA signal including at least one user data channel and a separate pilot channel received over a plurality of L paths, where the desired data channel is orthogonal to the pilot channel for a given path."

While the word "orthogonal" is used in both instances, it denotes two different relationships. In claim 1, it denotes that signal components on different subcarriers are orthogonal to each other. In contrast, in Huang et al., it denotes that data channel and pilot channel are orthogonal; there is no disclosure that the signal components are orthogonal. Therefore, examiner's allegation is not supported by the citation, i.e., col 2, lines 11-25 of Huang et al.

2) Figure 6, Figure 22, and Figure 23

The claimed subject matter in claim 1 is "reconstructing a predetermined number of times, by a reconstructing module, said identified one or more signal components to thereby reduce noise in said identified one or more components".

The relevant part in Figures 6, 22 and 23 is the reconstructing step. All three Figures explicitly show that ALL pilot signals are reconstructed for the subsequent cancellation.

While the "reconstructing" operation is performed in both algorithms, the operation is performed in completely different manners. In claim 1, only the "identified one or more signal components" are reconstructed for noise reduction for subsequent replacement. In contrast, in Huang et al., ALL pilot signals are reconstructed for the subsequent cancellation. It is evident that the reconstructing step in claim 1 is not disclosed or suggested by Huang et al.

Therefore, the examiner's attempt to equal these two reconstructing operations is not supported by the Figures 6, 22 and 23 of Huang et al.

3) Figure 8; col 7, lines 65-67; col 8, lines 1-22

The claimed subject matter in claim 1 is "replacing said identified one or more signal components for reconstruction in said received transformed signal with the reconstructed one or more signal components to provide a new transformed signal having one or more reconstructed signal components with reduced noise".

The relevant part of the citations (Figure 8; col 7, lines 65-67; col 8, lines 1-22) is the operation of cancellation; it specifically shows that in a two-path (path 0 and path 1) situation, the recovered pilot signal from path 0 is subtracted (or cancelled) from the path 1 signal, and the recovered pilot signal from path 1 is subtracted from the path 0 signal. It is clear that the cancellation is performed by subtracting the pilot signal from one path (e.g., path 0) with the pilot signal from another path (e.g., path 1), where all pilot signals are subtracted from all signals.

The claimed "replacing" operation in claim 1 and the disclosed "cancellation" operation in Huang et al. share nothing in common. In claim 1, the replacement is performed by replacing one original and un-reconstructed

signal with the reconstructed signal that is corresponding to the original signal; there is no involvement of other signals for the operation of replacement. In contrast, in Huang et al., the cancellation (i.e., subtraction) is performed by subtracting the pilot signal of one signal with the pilot signal of another signal, involving all signals in the operation. It is evident that the "replacing" operation in claim 1 is not disclosed or suggested by Huang et al. Therefore, the examiner's allegation that the "replacing" is equal to the "cancellation" is not supported by the Figure 8; col 7, lines 65-67; col 8, lines 1-22 of Huang et al.

Conclusion

Claims 1-34 are not unpatentable over Huang et al. in view of Kadous et al. or further in view of Dabak et al. for the above reasons even if they are impermissibly combined; therefore applicant respectfully request that the rejections be withdrawn.

Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

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